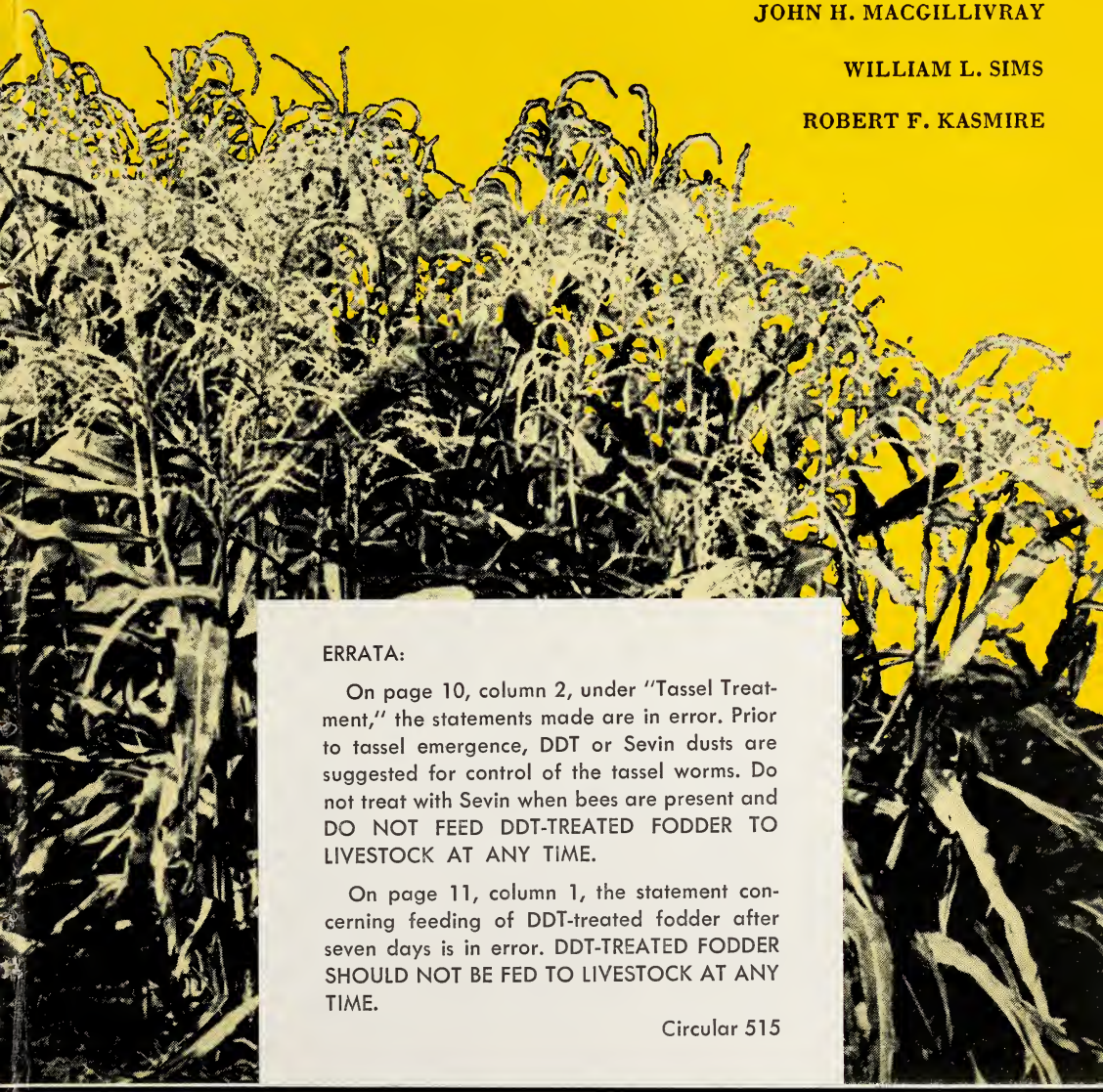
Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA

SWEET CORN
PRODUCTION IN CALIFORNIA

JOHN H. MACGILLIVRAY
WILLIAM L. SIMS
ROBERT F. KASMIRE



ERRATA:

On page 10, column 2, under "Tassel Treatment," the statements made are in error. Prior to tassel emergence, DDT or Sevin dusts are suggested for control of the tassel worms. Do not treat with Sevin when bees are present and DO NOT FEED DDT-TREATED FODDER TO LIVESTOCK AT ANY TIME.

On page 11, column 1, the statement concerning feeding of DDT-treated fodder after seven days is in error. DDT-TREATED FODDER SHOULD NOT BE FED TO LIVESTOCK AT ANY TIME.

Circular 515

CALIFORNIA AGRICULTURAL
Experiment Station
Extension Service

CIRCULAR 515

SWEET CORN PR

Corn on the cob,

a summer favorite on dinner menus, is one of our most perishable vegetables. Without artificial help, sweet corn, harvested at its prime, starts to lose quality as soon as it is picked. The grower's greatest problem, then, is getting the ears from the field to the local market in prime eating condition. This circular describes field practices, harvesting, and cooling methods that will aid considerably in improving sweet corn quality.

If you are

A FARMER, thinking of adding sweet corn to your market crops, this circular offers guidance ranging from the selection of suitable varieties to grow to the readying of the harvested product for sale.

A SWEET CORN PRODUCER, looking for ways to improve the market quality of your product, you will be particularly interested in the sections on varieties (pages 5 and 6) and on cooling methods (pages 16 and 17).

A HOME GARDENER, for special tips, see page 22.

JULY 1962

JOHN H. MACGILLIVRAY • WILLIAM L. SIMS • ROBERT F. KASMIRE

...UCTION IN CALIFORNIA

SWEET CORN is a warm-season vegetable that has become a staple crop in California. Approximately 22,000 acres are devoted to sweet corn in this state, and annual production averages about 95,000 tons.

Almost the entire crop is for home consumption. Most of it is sold fresh on California markets, a small amount is delivered to freezers. Occasionally a carload is shipped out of the state, and a few out-of-state shipments are received during the nonproductive winter months. However, since sweet corn is highly perishable, long-distance shipment is, on the whole, impractical.

THE AUTHORS: JOHN H. MACGILLIVRAY is *Professor of Vegetable Crops and Olericulturist* in the Experiment Station, Davis. WILLIAM L. SIMS is *Extension Specialist in Vegetable Crops*, Davis. ROBERT F. KASMIRE is *Extension Marketing Technologist*, Davis.

Quality corn in prime condition is readily marketable. While disease and insect pests are a perennial hazard and proper harvesting presents certain problems, these phases of production are not the producer's greatest obstacles. Good quality is not too difficult to achieve, and yet much of the corn sold in retail markets is of poor quality—largely because of inadequate cooling and lax handling practices.

The grower's chief problem is to maintain high quality from the time the ears have been harvested until they reach the consumer. To do this, the corn must be adequately cooled and stored at low temperatures.

While better pest control and harvesting practices are always being sought, sweet corn production is most likely to be improved by better ways of handling the ears after harvest.

The methods described in this circular would improve quality considerably. How far growers should go in this direction, however, will depend on economic conditions, the interest and cooperation of people in the trade, and the demands of the consumer.

Where corn is grown

Sweet corn can be grown in most areas of California, although the greatest acreages are in the southern part of the state. Riverside, Kern, San Bernardino, Los Angeles, Alameda, Orange, Contra Costa, and San Joaquin are the important sweet corn-producing counties. Smaller acreages are grown in other counties of the San Francisco Bay region, in most of the counties of the San Joaquin Valley, in the Delta region, and San Diego County. In Riverside County most of the acreage centers in the Coachella Valley, with a small amount in the Palo Verde Valley. Chino is the main district in San Bernardino County.

Favorable growing conditions

Warm days and nights provide the best climatic growing conditions. Frost will injure the plants at any stage of growth. For germination, soil temperatures between 70° and 80° F are best, and should not be below 55° F. Air temperatures above 95° F or hot, drying winds may cause poor pollination, and if such conditions prevail during the harvesting season, sweet corn will pass through prime condition very quickly. Also, diseases, such as ear rot, are likely to develop if the weather is very hot and humidity is high.

Sweet corn is grown on all soil types, from sandy loams to clay loams, as well as peats or muck. Sandy loam soils are preferred for the early spring crops, but in warm districts heavier soils may be selected. Sweet corn appears to be moderately tolerant of salt or alkali.

Growing periods differ in length . . .

The length of the growing period from seeding to first harvest varies with the variety, the planting date, the season of the year, and the district.

January plantings of Golden Cross Bantam in the Coachella Valley may take 120 to 130 days to reach maturity, while late February seedings take about 100 days. April and May plantings in the Central Valley take 75 to 100 days, in the coastal counties, 95 to 120 days. (See box, page 15.)

The growing period for the early or quick-growing varieties may range from 55 to 110 days; they usually mature 5 to 15 days sooner than Golden Cross Bantam planted at the same time. Summer plantings for fall harvest will require a longer growing season than mid-spring plantings allow. The harvest from one planting usually extends over 7 to 10 days.

The peak harvest period in California is June through August. Production during May, September, October, and November is about one third that of the peak months. In the Coachella Valley harvesting sometimes starts in late April on plantings of early varieties or on those started under paper protectors.

. . . and yield is also variable

Yields range from 500 to 1,800 dozen marketable ears per acre. Late varieties normally yield higher than early-maturing ones, and crops grown under favorable conditions produce more than those subjected to long periods of cool weather, short days, or excessively high temperatures. The ear weight of Golden Cross Bantam may vary from 5 to 8 pounds per dozen, depending on the growing conditions.

Some growers also market some of their sweet corn as fodder for livestock. Fodder yields vary with the height of plants, 5-foot plants producing 7.5 tons

A mature ear of a Golden Cross strain.

per acre, 6-foot plants 11 tons, and 8-foot plants 13 tons.

What variety to plant

A golden corn that produces large ears of good quality is preferred at the present time. In general, the hybrid varieties give higher yields, are more uniform in maturity and type, and are of better quality than the rarely grown open-pollinated varieties.

In 1954 an extensive variety test was made in 17 counties in the state by the Department of Vegetable Crops and the Extension Service. The average yield for the main-season varieties varied from 5.4 to 7.5 tons per acre. Seven Golden Cross Bantam strains were used in the various tests. In the ten main-season varieties four strains of Golden Cross Bantam varied in yield from 5.4 to 6 tons per acre. The highest yields were produced by Code 197, Victory Golden, and Hybrid 73. Both Victory Golden and Hybrid 73 were rated high in quality as well as in yield. The earliest variety was Marcross S.

Golden Cross Bantam is the main variety grown in California. The numerous strains of this hybrid vary in yield, quality, type of plant, and adaptation, therefore you should test several strains to determine which one is most suitable for your growing conditions and market outlet. Because of problems involved in growing hybrid seed, a given strain may change slightly from year to year. At present, many growers prefer the so-called "T" strains.

Seneca Chief is a medium-early golden hybrid corn of excellent quality, developed primarily for freezing. Its relatively small ear tends to discredit it for the fresh market.

Carmelcross, Marcross C 13.6, and **Seneca Dawn** are quick-maturing golden hybrid varieties sometimes used for the first plantings in a district. Seneca Dawn is the earliest but has the poorest quality of this group.

Golden Bantam, an old, open-pollinated variety, has high quality but lacks

the yielding capacity and uniformity of Golden Cross Bantam.

Golden Security yields well but eating qualities appear to be average.

Seed production

Very little sweet corn seed is produced in California. Hybrid seed is grown by commercial seed companies located mainly in the northwest and middlewestern areas of the United States. Seeds of open-pollinated varieties can be saved by individual growers if he will avoid mixtures with other varieties and other types of corn.

Do not save seed from hybrid corn because it will be variable in the next generation.

Good cultural practices will pay off in higher yields of better corn

Crop rotation

A crop-rotation program will prevent the build-up of smut in the soil and maintain good soil conditions. A desirable rotation is barley, tomatoes, lettuce, and sweet corn.

Field preparation

In the Coachella Valley it is customary to preirrigate to leach out excessive salts and to provide moisture for preplanting tillage and for germination. In this region the early spring plantings are made on high peaked ridges or beds spaced 36 inches center to center. The corn is planted on the south side of beds running east to west, with the seed row about midway between the furrow and the peak of the ridge. The ridges are thrown up with lister shovels and shaped either be-

fore or at planting with special bed shapers.

In other areas and for summer plantings in the Coachella Valley, sweet corn is generally planted on the flat. A preirrigation may be necessary to supply moisture for germination of summer plantings, or, if this is impossible, a furrow can be formed beside the seed row at the time of seeding. Preplanting tillage should be just enough to work in crop residues and prepare an adequate seedbed. Excessive tillage wastes soil moisture and injures soil structure.

Seed

Use a good grade of seed. If you plant in cool, wet soil, seed treatment with a fungicide—Arasan SFX at ½ ounce per 150 pounds or Phygon at 1½ ounces per 150 pounds—may prove beneficial. If you suspect wireworms to be present, you may wish to combine lindane with the treatment (see the section on insects, page 10).

Spacing

Sweet corn is usually drilled in rows 36 inches apart, though this spacing may be adjusted to the equipment to be used. A desirable plant spacing in the row is 8 to 12 inches between plants of irrigated corn, or 12 to 16 inches if the crop is to be grown without irrigation. If the stand is thicker than this, thin to these distances when the plants are 3 to 4 inches high. Plant the seed 1 to 1½ inches deep, and firm the soil well over the seed.

About 15 pounds of seed per acre is suggested for plantings in early spring when germination may be poor. For later plantings, 8 to 12 pounds per acre is adequate unless the kernels are quite large.

Special bed shapers with the drills attached have been developed in the Coachella Valley for planting on the side of the ridges. With flat plantings, corn planters or small vegetable-seed drills may be used.

Make several successive plantings if you want a long harvest period. The interval can vary from three weeks between early spring plantings to one week in late spring.

Planting early sweet corn on the south side of the ridge promotes early growth by raising soil and air temperatures around the seed and seedlings. It also affords some frost protection.

Fertilizers

Sweet corn requires a high level of nitrogen during the early growing period. Nitrogen applications are likely to prove profitable on this crop in all areas except on summer plantings grown on very fertile soils. A rate of about 160 pounds of nitrogen (800 pounds of ammonium sulfate) per acre is recommended for early spring plantings, particularly those on the lighter soil types. A rate of 80 to 100 pounds of nitrogen may be adequate for later plantings. Nitrogen may be supplied by chemical fertilizers—for example, ammonium sulfate, ammonium nitrate, and aqua ammonia—or by manure.

Phosphorus applications may prove beneficial on some early plantings, particularly in the area south and west of the town of Coachella, in the Delta, on certain soil types in Kern, Fresno, and Tulare counties, and in the coastal districts of Los Angeles County. A rate of 100 pounds of phosphoric acid per acre should be adequate. Ammo-phos 16–20 is a good chemical fertilizer when both nitrogen and phosphorus are to be supplied.

Most California soil contains enough of the other nutrients—potassium, magnesium, iron, and so on—and therefore these seldom need to be supplied in fertilizers. However, zinc deficiencies have been found in several production areas of the state. This deficiency affects both quality and yields.

Barnyard manure at 10 to 12 tons per acre, or poultry manure at 4 to 5 tons, should be worked into the soil before

planting. Occasionally chemical fertilizers are broadcast before planting and disked in, but usually they are drilled in bands 4 to 6 inches deep and just to the side of the seed row at planting time. At least half of the nitrogen and all of the phosphorus should be applied at planting time. A second application of nitrogen is often made four to six weeks after planting; it may be applied as a side-dressing, or you may add anhydrous ammonia to the irrigation water. Applications of fertilizer after midseason will seldom prove of value except to give greener husks if the corn has turned yellowish green. Results of fertilizer tests in the Coachella Valley indicate that shriveling in the kernels can be reduced by application of nitrogen at the early tassel stage.

Weeding and cultivation

One or more early cultivations are needed to control weeds and to establish irrigation furrows. Some weeding can be combined with thinning operations. Keep all cultivation close to the plant shallow to avoid disturbing the root system. Stove oil or fortified diesel oil can sometimes be used at the rate of 25 to 30 gallons per acre as a pre-emergence weed spray to take the place of an early cultivation.

If morning glory or certain other broadleaf weeds cannot be controlled by cultivation, one application of 2,4-D may be made when the plants are 12 inches high. Use the salt form at a rate of ½ pound in 20–40 gallons of water per acre. If possible, direct the spray cones at the base of the plants and avoid the leaves as much as possible.

Irrigation

Young sweet corn plants have a rather coarse, shallow root system, but as the plant approaches maturity, the root system becomes more fibrous and will penetrate to a depth of 3 feet or slightly more in tall varieties with a large plant.

Leaves rolled as shown are a sign of insufficient water. For best yields and ear size, do not allow corn to become this dry.

A crop requires 12 to 25 acre-inches of water. Summer plants in the interior valleys need more water than early spring plantings or crops grown on the coast. Irrigation in furrows is the usual practice, though the flood method or sprinklers can be used.

With good soil moisture at planting time, an irrigation during the germination period is seldom necessary in cool weather. In hot weather one irrigation during this period may be necessary to obtain maximum and rapid germination.

Start regular irrigation when the plants are 3 to 6 inches tall. This first irrigation can be quite important for obtaining maximum yields, and, because of the coarse root system, it may be needed even though the soil appears to be fairly wet. At first, intervals of two to three weeks between irrigations may suffice unless the weather is very hot. As the

crop advances, gradually shorten the intervals until irrigations are applied about once a week just before harvest. Late fall plantings, however, may require less frequent irrigations later on as the weather grows cooler.

Apply 2 to 4 acre-inches of water at each irrigation. On hot days, corn leaves may roll for an hour or two without danger of injury, but if the leaves remain rolled in the early morning, this is a sign that irrigation is needed. The most crucial stages occur apparently during the early growing period, during tasseling, and at harvest.

Some early sweet corn is produced without irrigation in the coastal districts of Los Angeles and Santa Cruz counties, in certain localities near San Francisco Bay, and in the Marsh Creek district of Contra Costa County. You can obtain fair yields if you select soils with a high water-holding capacity, such as clay loams, and if the crop is not planted too thickly.

Suckering

Claims have been made that suckering (the removal of side shoots or suckers) will increase both yields and the size of ears. Numerous tests conducted in California and other states have, however, shown that the removal of suckers is not beneficial to Golden Cross Bantam and similar varieties. Neither yield nor size of ear has been increased, and in some

Irrigation is often important when corn is about as high as shown in this photo. Later, water will be applied in every row to wet a maximum amount of soil. Adequate irrigation is essential for good production.

tests yields have been materially reduced by suckering.

A few tests have indicated that in early spring plantings the crop may reach the harvest stage a few days earlier when the corn is suckered. This may, therefore, be a factor to consider on the first plantings in a given district. There has also been some indication that varieties may vary in their response to suckering. Therefore, if you use a variety distinctly different from Golden Cross Bantam, it would be well to test the practice before definitely deciding whether or not to sucker.

Some growers sucker their corn because they believe it reduces the labor needed to dust for corn earworm and to harvest the ears. This may be true, but it is unlikely that the savings will make up for the cost of suckering. A recent test at Davis showed that it took 13 hours of labor per acre to sucker, dust, and harvest one ton of corn. An acre of unsuckered corn was dusted and harvested in 10.6 hours.

Pests and diseases must be controlled

Insect control

Resistant hybrids and good soil-management practices help reduce insect damage. Nevertheless, sweet corn in California is subject to attack by several insect pests that can be controlled only by chemical methods.

Corn earworm. The best-known and most destructive insect on corn in California is the corn earworm. Earworms may be abundant on any planting, though they are usually more serious late in the season. The night-flying moths normally lay the eggs on the silks. The moth is a light brown or buff colored moth with a wing spread of about 2 inches. The tiny, dome-shaped eggs hatch in two to ten days and the young worms work their way down the silk channel to the ear. Sometimes before the silks appear, the eggs are laid on the tassels and the worms migrate to the ears later, entering through the side (sideworms).

The corn earworm can be a serious pest.

Larvae leave the ears by boring out the side or crawling out the tip and go to the ground to pupate. The pupae pass through the winter 3 to 5 inches deep in the soil, and adults emerge in certain areas as early as late March. Infestations are present as late as the middle of November.

With the exception of the lesser cornstalk borer, the earworm is the most difficult pest to control on sweet corn.

Control. DDT and Sevin are currently recommended for control of the earworm. Inasmuch as the suggested rates of these chemicals and others used on corn may change periodically, ask your local Farm Advisor for the current "Vegetable Crop Pest Control Guide."

Tassel treatment is necessary in some areas. To control sideworms, apply DDT or Sevin dusts starting when the tassels are three-quarters open.

Dusting sweet corn for corn earworm control. Dust is applied every three days after silking, or eight to ten times per crop.

Do not feed DDT-treated or Sevin-treated fodder in less than *seven* days after last application.

Individual ear treatment for moderate to heavy infestation. To within *one* day of harvest DDT and Sevin dusts can be applied by a stencil brush by hand to each ear starting when silks first appear. Three to four applications are necessary at three-day intervals. You can also hand spray with DDT or Sevin in mineral oil and water, applied to each ear by a hand gun. Three to four applications are necessary at five-day intervals. Do not overdose to avoid injury.

If you did not dust or spray the individual ears, you may use a late treatment when the silks are turning brown by injecting a DDT-mineral oil mixture into each ear using ½ ml. (1/9 teaspoonful) per ear. Do not overdose as injury and excessive residues may result.

Fixed boom spraying. DDT and Sevin can be used in mineral oil and water applied by a fixed boom. Four nozzles are arranged per row to cover the ears. Usually three to five applications are necessary, applied at three-day intervals.

Ground and air dusting for light to moderate infestations. Dusts of DDT and

Sevin are effective under light to moderate infestations applied by ground dusters. Three to five applications are necessary at three- to four-day intervals. With this method thorough coverage is essential. Dust treatment by airplane is effective only on light population levels and is seldom practical in California.

Corn aphids. Several species of aphids, primarily the apple grain aphid and the corn leaf aphid, become abundant enough on corn to make the foliage and ears sticky with honeydew. A black, sooty mold develops on the ears and makes them unsightly. Control is usually not necessary.

Armyworms and cutworms. Several species of cutworms and armyworms damage corn. Cutworms hide in the soil during the day and cut off the plants or bore up inside the stalks at the ground level. Armyworms often have the habit of marching like an army from one field to another and may attack the plant at any level. The black cutworm and variegated cutworm often cut off the small plants. The beet armyworm prefers small plants, often doing considerable webbing of the foliage. The fall armyworm, on the other hand, attacks all stages and all parts of the corn plant, even the ears. DDT dusts and sprays are usually effective. *Do not feed the fodder.*

Spider mites. The Atlantic, two-spotted spider mite, and others, sometimes cause severe damage to sweet corn. The plants become yellow and are covered with a fine silk webbing. Spider mites may affect yield, but usually merely discolor or disfigure the appearance of the ears. Control, while usually not necessary, can be achieved by certain phosphate materials.

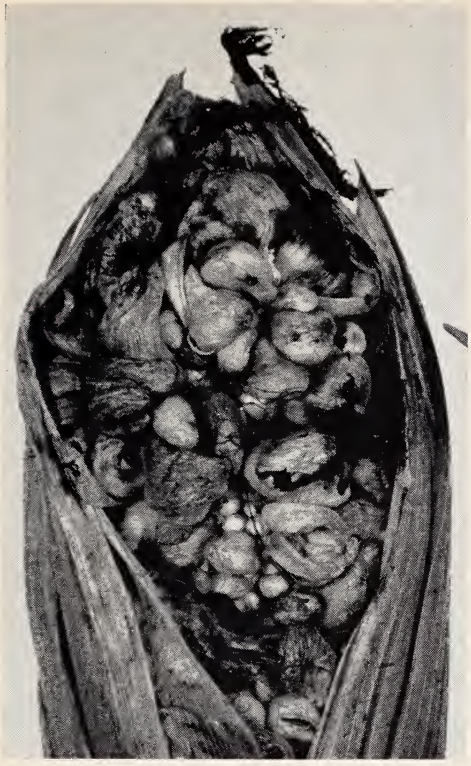
Lesser cornstalk borer. This borer is an occasional pest of seedling plants. The active caterpillars bore into the roots and stems at the ground level. Fall and winter cleanup of trash and crop rotation assist in its control. Aldrin is effective if applied as granules at the time of planting, or as granules or spray at the time the plants are one-half to one inch tall. The granules or sprays are applied in a band 3 to 5 inches wide over the seed furrow or seedling plants.

Cutworm and damage to young corn plant.

Darkling ground beetles. Small darkling ground beetles occasionally attack young seedling corn plants. They girdle the plants. DDT as used for cutworms and armyworms is usually an effective control.

Fleabeetles. These small jumping beetles often attack seedling plants, and may attack larger plants. They gouge out areas in the leaves, causing the leaves to dry back to the stalk. DDT has given good control.

Seed corn maggots and wireworms. These pests feed on the germinating seeds. Seed can be treated prior to planting with a fungicide-insecticide mixture. Lindane or dieldrin are com-



An ear of corn showing severe smut damage.

monly used with a good fungicide and usually give satisfactory protection.

Disease control

In spite of sound cultural practices, sweet corn crops in California are prey to certain diseases. Most common are the following:

Smut. Boil smut, the most common disease of corn in California causes large, fleshy, irregular swellings on the stems, ears, or tassels and may occur at any stage of growth. The spores survive in the soil, hence the problem can be at least reduced by a crop-rotation program.

Seed treatment, which will prevent pre-emergence seedling loss from other organisms, is not effective in controlling smut. If corn smut occurs, remove the diseased plants or parts and destroy them, preferably by burning.

No preventive or control measures are available against smut. However, crop rotation and the burning of affected stalks will help reduce the prevalence of this disease.

Ear mold, pink rot. Several fungi, particularly *Fusarium moniliforme*, may develop on ears in the field, usually in worm-damaged ears. The ears become moldy and the kernels may split open and turn a pinkish color, which ruins the corn for market. This trouble usually develops only in heavily irrigated fields during periods of high temperatures. The best control is to prevent worm damage.

Root Rot. This disease, caused by one of the water mold fungi (*Pythium graminicola*), is known only in southern California primarily on early maturing varieties when grown in late summer. The leaves of infected plants become rolled and wilted. Young plants die rapidly while older plants (two to three months old) often remain partially wilted for several days before dying. Roots of affected plants are brown and appear water soaked. The rot may extend into the subcrown internode but seldom above the crown.

No general control measures have been developed for this disease. However, since root rot is associated with certain varieties, avoid early maturing types in late summer plantings; this should help keep down damage from this disease.

In harvesting, quality depends on careful timing of operations

Development of the ear

Good pollination is essential for well-filled, fully developed ears. The silks keep growing until fertilized by the pollen, carried to them from the tassels by wind and gravity; then they begin to dry and sometimes turn brown. Hot weather, dry winds, or dry soil conditions may

Maturity of corn: the ear on the left is immature; that in the center just right; the one on the right slightly overmature.

cause failures in pollination or set of kernels.

During the summer, corn reaches prime eating condition about three weeks from the time the silks appear. In late fall the interval may be four to five weeks.

As the ear approaches maturity, sugar changes to starch, the hull becomes tougher, and the kernels pass through stages called pre-milk, milk, early dough, and dough stages. At field temperatures of around 60° F an ear remains in prime condition for about five days; at 85° F it passes through this stage in one to two days.

When and how to harvest

As the field approaches maturity, a few ears should be examined occasionally to determine the time for the first picking. An ear at the proper stage is fully sized for the variety, its husk is tight, and the silks are somewhat dried. The kernels are fully developed, bright yellow for golden varieties and, if punctured, show a milky liquid. Since the husks should not be disturbed during harvesting, the picking crew should use only external characteristics in selecting the ears that are ready.

The ears are harvested by hand with a downward twisting motion and are carried out of the field in high-wheeled trailers, in picking sacks, or on horse-drawn sleds. Since all the ears do not reach maturity at the same time, a field should be picked two or three times in order to harvest all of the corn at the best stage.

Corn for processing is usually harvested by mechanical equipment with a saving of labor. Small acreages and crushing of the kernels has prevented their use for market corn.

Harvesting and hauling

Sweet corn loses its quality rapidly after harvest. The higher its temperature after harvest, the faster the loss of the corn's eating quality (sweetness and freshness of kernels). For example, at 50° F, sweet corn loses its sugars three times faster than it does at 32° F; at 68° F, six times faster; at 86° F, twelve times faster, and at 104° F, about twenty-four times faster. High temperatures are not uncommon in corn in bulk trailers during the time between harvest and precooling. The longer this period, the higher will be the corn's temperature. To maintain maximum quality, sweet corn should be moved quickly from harvest to packing shed, where it should be rapidly sorted, packed, and precooled. This is especially true for corn harvested from about mid-day on. Corn harvested early in the morning will be 10° to 25° F cooler than that harvested later in the day.

To maintain maximum quality:

- Harvest corn as early in the day as possible.
- Haul corn quickly from field to packing shed.
- Process the corn through the packing shed rapidly. Do not let bulk trailers of sweet corn stand for prolonged periods (e.g., during the noon hour) while awaiting unloading at the shed.
- Precool the corn as thoroughly as possible.

Sorting

Good corn should have green, fresh husks with streamers and well-filled long ears that are relatively free from defects. Discard all ears showing side-holes made by corn earworms, smut, mold, or serious tip damage from worms. Most growers discard ears that have less than 4 inches of good kernels, that are under- or overmature, or have severely damaged husks. Some growers make two grades of corn, based on the length of the ear. Only high quality corn should be packed for marketing. Poor quality discourages repeat sales.

Sweet corn offered for sale must meet the following minimum requirements of the California Agricultural Code:

> Ears of green corn shall be free from serious damage caused by smut or other diseases, mold, decay, or fermentation, insects or other causes. Damage from any cause shall be considered serious if it affects any of the kernels below a distance from the tip of more than 25 per cent of the length of

Seeding and Harvest Dates for Sweet Corn

DISTRICT	USUAL PLANTING PERIOD	MAIN HARVEST PERIOD
Coachella Valley	January to March August	May and early June November and early December
San Joaquin Valley	March and April June and July	June to early August October to early December
Southern California	March to July	Late June to early November
San Francisco Bay area	April to July	July to October
Delta region	April to June	Late July to September

the cob. In addition, the kernels on at least one-half of the length of the cob shall be plump, milky, and well developed, but not shriveled.

Not more than 10 per cent, by count, of the ears in any one lot of containers or bulk lot may be below these requirements but no container shall have more than 20 per cent, by count, of ears which are below these requirements.*

Since these requirements are subject to revision, be sure to consult the current Code or see your local Agricultural Commissioner.

Packaging

Sorting and packing are hand operations that can be carried out in any shaded location on the ranch. When large quantities of corn are to be handled, well-organized packing sheds will speed the work and increase labor efficiency.

Sweet corn is generally packed in wirebound corn crates, with four to six dozen ears per crate, depending on the sizes of ears. The wirebound crate is 7¾″ x 14″ x 21¾″. In the lug and crate, the corn is arranged in layers of 8 to 12 ears. Various types of unlidded containers (apple boxes, L.A. lugs, and W.G.A. crates) are also used for direct shipments to nearby outlets. The corn is arranged in layers in both types of containers.

Cooling methods are very important for the marketing of this perishable crop

Precooling

As sweet corn is very perishable, and loses its quality (sugar) and appearance rapidly at high temperatures, quick and thorough precooling followed by cold storage will help retain the quality.

Precooling means fast removal of field heat. This lowering of the corn's temperature also lowers its "rate of living" (respiration rate, etc.). Sweet corn should be precooled as close to 32° F as possible, although it is rarely cooled below 40° F in commercial practices.

Hydrocooling, the most common precooling method used for sweet corn, consists of either showering the corn or immersing it in cold water. thus transferring the corn's heat to the water. The warmed water is conducted to an ice bunker and passed over the ice. cooling the water and melting the ice. The cooled water is then transported back to the shower or immersion tank where it is again used for cooling the corn. In some hydrocoolers mechanical refrigeration systems are used instead of ice to cool the water. *In ice-cooled systems it is important to remember that the ice must melt in order to cool the water.* The water will cool faster with crushed ice than with chunk ice. For further information on this subject see "Facts on Hydrocooling Sweet Corn" by R. F. Kasmire and A. F. Van Maren, which may be obtained from your Farm Advisor.

Vacuum cooling. Sweet corn is also commercially precooled by vacuum cooling. The corn is submerged in cold water just before being placed in the vacuum tube. This practice aids in surface cooling and prevents excessive loss of moisture from husk leaves during the vacuum cooling process. This method of precooling appears to be best adapted for custom vacuum cooling operations. because of the high cost of facilities and operations.

Package icing

Package icing is the most efficient method of cooling sweet corn. It is used to only a limited extent in California,

* Extracts from the Agricultural Code of California. Bureau of Fruit and Vegetable Standardization, Department of Agriculture, Sacramento. Revised to 1961, Section 813.7.

mostly for local, direct shipments. Growers who want to improve their market quality should give it strong consideration.

In this method 15 to 25 pounds of crushed ice is distributed throughout the container during the packing process. The corn is cooled rapidly and efficiently because of its continued direct contact with the ice. Furthermore, ice can be kept in the container during the entire marketing period, greatly extending the length of time low temperatures can be maintained.

The amount of ice needed in the package depends on the temperature of the corn at the time of packing and on the expected length of marketing period. Precooling to remove part of the field heat may permit the use of less ice or, in the case of long marketing periods, may extend the length of time ice will remain in the package. The wire-bound "corn crate" or one slightly larger makes a suitable container.

The main disadvantages of package icing are that the pack may be somewhat slack on arrival in the market and the package is heavier and wet.

Cold storage

To maintain best quality, place sweet corn in cold storage immediately after precooling. The cold storage can be in a refrigerated truck, rail car, or in a cold storage holding room. Hold temperature as close to 32° F as possible without freezing the corn. Keep the cold storage facility moist to prevent drying of the husks. Do not hold corn for more than a few days in cold rooms while accumulating loads. Quality loss increases with length of holding period.

Icing in transit

The best method consists in distributing crushed ice over the load (top icing) or through the load (body icing) in trucks or railway cars. This method helps to keep temperatures low during transit but provides little or no additional cooling. Icing in transit is desirable for hauls of 75 miles or more, especially if the corn has been precooled or package iced.

Marketing . . . the local market is usually the most practical outlet

Sweet corn is best adapted for marketing close to the production district. Distant shipments are hazardous; they should not be attempted unless the corn is of excellent quality and fairly free from worms, and unless its temperature can be lowered quickly to 38° F and held there.

Even with nearby outlets, sweet corn must be marketed in an orderly fashion if losses are to be avoided. Because it is highly perishable, it must be moved quickly. If the market becomes flooded, either prices drop drastically or a good deal of corn goes to waste.

Orderly marketing can be encouraged by:

- Spreading the plantings to give a steady supply of corn during the entire harvest period for the district.
- Offering only high-quality corn for sale.
- Maintaining uniform packaging and grades.
- Advising marketing outlets in advance when the harvest season will start so they can develop outlets before the shipments arrive.
- Avoiding heavy shipments when the market is filled with corn.

Production Costs

A study made in San Bernardino County in 1961 gives a representative figure for production costs (table 3). With a yield of 200 five-dozen crates per acre, the cost per crate is $1.69. Land preparation is 3¢; cultural operations 54¢; harvest operations 39¢; cash overhead 9¢; and noncash costs 64¢ per crate. Studies in other counties vary as to the cost per crate depending on the time of year produced and also on whether packing and marketing costs are included.

California District Classification

NOTE: The classification of districts for the segregation of truck receipts originating within California which had been in use during the period from 1937 through 1956 was changed to some extent beginning with 1957. For this reason certain district totals for 1957–1960 may not be comparable with those of former years. The new classification is believed to be more in line with modern production patterns and provides more useful detail than the previous classification.

The district classifications used since 1956 are based primarily on county lines and are as follows:

1. *San Francisco Bay District*—Alameda, Western Contra Costa, San Francisco, San Mateo, and Santa Clara counties.
2. *North Coast District*—Marin, Sonoma, Napa, Lake, Mendocino, Humboldt, Trinity, and Del Norte counties.
3. *Tulelake District*—Siskiyou and Modoc counties.
4. *Northern Central Valley District*—San Joaquin, Eastern Contra Costa, Solano, Sacramento, Yolo, Sutter, Yuba, Butte, Colusa, Glenn, Tehama, Shasta, Lassen, Plumas, Sierra, Nevada, El Dorado, Alpine, and Amador counties.
5. *Southern Central Valley District*—Kern, Tulare, Kings, Fresno, Madera, Merced, Stanislaus, Calaveras, Tuolumne, Mariposa, Mono, and Inyo counties.
6. *Monterey-Santa Cruz-San Benito District*—Monterey, Santa Cruz, and San Benito counties.
7. *San Luis Obispo-Santa Barbara-Ventura District*—San Luis Obispo, Santa Barbara and Ventura counties.
8. *Los Angeles District*—Los Angeles, Orange, Riverside (exclusive of Coachella Valley and Blythe District), and San Bernardino counties.
9. *Coachella Valley.*
10. *Imperial Valley.*
11. *San Diego County.*
12. *Blythe District*—Palo Verde Valley.

Table 1. San Francisco–Oakland Markets: Sweet corn unloads in cars and carlot equivalents—1961

Origin	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Sub-total	Total per state
By state:														
Florida (rail)	..	1	..	1	..	..	..	..	..	..	..	..	2	...
Florida (truck)	3	2	8	12	1	..	..	..	..	..	..	8	34	36
Arizona (truck)	..	..	..	..	2	12	..	..	..	..	..	..	...	14
California (rail)	..	..	..	..	..	7	1	1	..	..	..	..	9	...
California (truck)	..	..	..	2	114	144	205	156	107	77	63	6	874	883
Oregon (truck)	..	..	..	..	..	..	..	2	8	1	..	..	...	11
Washington (truck)	..	..	..	..	..	..	..	3	2	1	..	..	...	6
Total unloads	3	3	8	15	117	163	206	162	117	79	63	14	...	950
Truck unloads by California production districts:*														
Coachella Valley	..	..	..	2	102	50	7	..	..	..	2	3	166	...
Blythe District	..	..	..	..	10	10	..	..	..	..	..	..	20	...
Los Angeles District	..	..	..	..	2	6	4	2	..	1	3	..	18	...
South Central Valley	..	..	..	..	..	72	25	7	7	37	49	3	200	...
North Central Valley	..	..	..	..	..	6	97	29	2	2	6	..	142	...
San Francisco Bay Area	..	..	..	..	..	..	72	116	97	37	3	..	325	...
Monterey-S. Cruz-S. Benito Co.	..	..	..	..	..	..	..	1	1	..	..	..	2	...
North Coast District	..	..	..	..	..	..	..	1	..	..	..	..	1	...
Total California truck unloads	..	..	..	2	114	144	205	156	107	77	63	6	...	874

* See note page 18.
Source: Hugh E. Myers, Federal-State Market News Service, Sacramento.

Table 2. Los Angeles Market: Sweet corn unloads in cars and carlot equivalents—1961

Origin	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Sub-total	Total per state
By state:														
Florida (truck)	15	12	23	36	1	..	..	..	..	..	..	34	....	121
California (rail)	..	..	..	..	8	14	40	15	..	1	10	2	90	....
California (truck)	3	..	..	20	443	406	494	350	171	204	160	24	2,275	2,365
Arizona (truck)	..	..	..	..	6	12	..	..	..	..	..	..	....	18
Texas (truck)	..	..	..	..	6	..	..	..	..	..	..	..	....	6
Idaho (truck)	..	..	..	..	..	..	..	3	..	..	..	..	....	3
Washington (truck)	..	..	..	..	..	..	..	5	3	..	..	..	....	8
Oregon (truck)	..	..	..	..	..	..	..	..	8	..	..	..	....	8
Minnesota (truck)	..	..	..	..	..	..	..	..	1	..	..	..	....	1
By foreign country:														
Mexico (truck)	..	3	..	3	..	..	..	..	..	..	..	..	....	6
Total unloads	18	15	23	59	464	432	534	373	183	205	170	60	....	2,536
Truck unloads by California production districts:*														
Coachella Valley	3	..	..	20	416	209	..	..	..	14	48	20	....	730
Blythe District	..	..	..	..	25	3	..	..	..	..	..	..	....	28
Imperial Valley	..	..	..	..	2	..	..	..	..	..	..	..	....	2
Los Angeles District	..	..	..	..	..	87	454	342	139	131	59	3	....	1,215
South Central Valley	..	..	..	..	..	101	18	..	4	55	49	1	....	228
San Diego County	..	..	..	..	..	6	..	1	..	2	..	..	....	9
North Central Valley	..	..	..	..	..	..	16	4	1	..	4	..	....	25
San Francisco Bay Area	..	..	..	..	..	..	3	2	20	..	..	..	....	25
S.L.O. Santa Barb. & Ventura	..	..	..	..	..	..	3	1	7	1	..	..	....	12
Monterey-S. Cruz-S. Benito Co.	..	..	..	..	..	..	..	..	..	1	..	..	....	1
Total Calif. truck unlds.	3	..	..	20	443	406	494	350	171	204	160	24	....	2,275

* See note page 18.
Source: Hugh E. Myers, Federal-State Market News Service, Sacramento.

Table 3. Sweet corn production costs in San Bernardino County, 1961.

(Based on a yield of 200 five-dozen crates per acre, man labor at $1.25 per hour and interest 6 per cent. Typical of Chino area.)

Prepared by JOHN VAN DAM and NORMAN WELCH, *Farm Advisors*

Operation	How often	Annual hours	Cost				
			Labor	Equipment	Material	Total	
Cash Costs							
Land Preparation							
Plow	1x	1.0	$ 1.25	$ 1.25		$ 2.50	
Disc and cultipack	2x	1.0	1.25	1.40		2.65	$ 5.15
Cultural Operations							
Plant and seed		0.5	.63	.60	12 lbs. seed @ 48¢ per lb. $ 5.76	6.99	
Fertilize	2x	0.8	1.00	.88	500 lbs. 15-20-0 10.00	11.88	
					800 lbs. Manure @ 2.5¢/cu. ft. 20.00	20.00	
					600 lbs. Am. Sul. 19.50	19.50	
Furrow out and cultivate		1.5	1.88	1.35		3.23	
Cultivate	3x	1.2	1.50	1.32		2.82	
Spray	6x	1.8	2.50	7.20	1½ gal. spray oil 75¢/gal. 2.63	12.33	
					Gallon of DDT @ 1.50 gal.		
Irrigate	27x	11.8	14.85		Water/$2.70; 40 lbs. NH_3/$4.00. 6.70	21.55	
Hand hoe		8.0	8.80			8.80	107.10
Harvest Operations					200 crates 15¢ each 30.00		
Haul, pick, pack		13.4	16.80	23.20	Ice, 4¢ per crate 8.00	78.00	78.00
Cash Overhead							
General expense (insurance, accounting, transportation, phone, etc.)						10.51	
Taxes						8.00	18.51
Total Cash Costs							$208.76
Non-Cash Costs							
Interest on investment						20.47	
Depreciation (equipment, irrigation system, buildings)						16.75	
Land value at 6 per cent for ½ year						91.50	128.72
Total Cost Per Acre							$337.48
Per crate							$ 1.69

Tips for the home gardener

If you want to raise just enough sweet corn for home use, follow these special tips:

Where ? Sweet corn can be grown in any area that has a warm, frost-free period lasting three months or more.

What ? Seneca Chief is a variety particularly well suited for the home garden.

Spacing: Plant the seed in hills spaced 2 feet apart. In thinning, leave two or three plants per hill. Pollination will be improved if plantings are made in blocks of three rows or more, rather than one or two long rows.

Fertilization: Very small amounts of fertilizers are needed—perhaps spoonfuls. Follow carefully the printed instructions that come with most commercial fertilizers. Most garden soils are lacking in the same elements as farm soils.

Irrigation: Probably best by hose. Just make sure the soil around the plants is moist (but not too wet) to a depth that will take in the root system of your plants.

Pest control: See section on pages 10 to 13. The pesticides recommended there are available in small quantities from nurserymen and hardware stores. Use them according to the printed instructions on the packages.

Harvesting: For best flavor, pick the corn when you are ready to eat it. If more ears are ready for harvest than you can use at once, store them immediately after picking, unhusked, in a cold (32°F), moist spot, but don't keep them longer than two or three days. Even under the best storage conditions, corn loses quality quickly.

Freezing: Corn that is to be frozen should have fully developed kernels. Avoid over-mature corn with starchy kernels and very yellowish color.

Acknowledgments

The authors wish to acknowledge the assistance of WILLIAM H. LANGE, JR., Department of Entomology, and DENNIS H. HALL, *Extension Specialist,* Department of Plant Pathology, who provided information for the sections on insect and disease control.

In order that the information in our publications may be more intelligible it is sometimes necessary to use trade names of products or equipment rather than complicated descriptive or chemical identifications. In so doing it is unavoidable in some cases that similar products which are on the market under other trade names may not be cited. No endorsement of named products is intended nor is criticism implied of similar products which are not mentioned.

Co-operative Extension work in Agriculture and Home Economics, College of Agriculture, University of California, and United States Department of Agriculture co-operating. Distributed in furtherance of the Acts of Congress of May 8, and June 30, 1914. George B. Alcorn, Director, California Agricultural Extension Service.

15*m*-7,'62(C7624)J.F.